
NATIONAL AERONAUTICS
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SECTION 16315

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06/04

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SECTION 16315

MEDIUM VOLTAGE OVERHEAD POWER DISTRIBUTION
06/04

NOTE: Delete, revise, or add to the text in this
section to cover project requirements. Notes are
for designer information and will not appear in the
final project specification.

This section covers poles, crossarms, hardware and
pins, guying, racks, and insulators. Use Section
16305 OVERHEAD HIGH-VOLTAGE WIRING for overhead
primary conductors. If connections between overhead
and underground primary are required, specify types
of potheads or terminators.

PART 1 GENERAL

1.1 REFERENCES

NOTE: The following references should not be
manually edited except to add new references.
References not used in the text will automatically
be deleted from this section of the project
specification.

The publications listed below form a part of this section to the extent
referenced:

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI C135.6	(1988) Zinc-Coated Ferrous Crossarm Braces for Overhead Line Construction
ANSI C29.2	(1992; R 1999) Insulators - Wet-Process Porcelain and Toughened Glass - Suspension Type
ANSI C29.3	(1986; R 1995) Wet Process Porcelain Insulators - Spool Type
ANSI C29.4	(1989; R 1995) Wet-Process Porcelain Insulators - Strain Type
ANSI C29.6	(1996; R 1996) Wet-Process Porcelain Insulators - High-Voltage Pin Type

ANSI C29.7 (1996) Porcelain Insulators - High-Voltage Line Post Type

ANSI O5.1 (2002) Wood Poles - Specifications and Dimensions

AMERICAN WOOD-PRESERVERS' ASSOCIATION (AWPA)

AWPA A3 (2000) Determining Penetration of Preservatives and Fire Retardants

AWPA C1 (2003) All Timber Products - Preservative Treatment by Pressure Processes

AWPA C25 (2001) Sawn Crossarms - Preservative Treatment by Pressure Processes

AWPA C4 (1995) Poles - Preservative Treatment by Pressure Processes

AWPA P5 (2001) Standards for Waterborne Preservatives

ASTM INTERNATIONAL (ASTM)

ASTM A 675/A 675M (2003) Standard Specification for Steel Bars, Carbon, Hot-Wrought, Special Quality, Mechanical Properties

ASTM D 1625 (1971; R 2000) Standard Specifications for Chromated Copper Arsenate

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C135.1 (1999) Standard for Zinc-Coated Steel Bolts and Nuts for Overhead Line Construction

IEEE C2 (2002) National Electrical Safety Code

1.2 SUBMITTALS

NOTE: Review submittal description (SD) definitions in Section 01330 SUBMITTAL PROCEDURES and edit the following list to reflect only the submittals required for the project. Submittals should be kept to the minimum required for adequate quality control. Include a columnar list of appropriate products and tests beneath each submittal description.

The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES in sufficient detail to show full compliance with the specification:

SD-01 Preconstruction Submittals

Material, Equipment and Fixture Schedule

SD-02 Shop Drawings

Fabrication Drawings
Installation Drawings

SD-03 Product Data

Manufacturer's product data shall be submitted for the following items:

Wood Poles
Crossarms and Timbers
Crossarm Braces
Hardware, Pins, and Racks
Insulators
Guys
Accessories

SD-07 Certificates

Certificates shall be submitted for the following items showing conformance with the referenced standards contained in this section.

Wood Poles
Crossarms and Timbers
Crossarm Braces
Hardware, Pins, and Racks
Insulators
Guys
Accessories

1.3 GENERAL REQUIREMENTS

NOTE: If Section 16003 GENERAL ELECTRICAL PROVISIONS is not included in the project specification, applicable requirements therefrom should be inserted and the following paragraph deleted.

Section 16003 GENERAL ELECTRICAL PROVISIONS applies to work specified in this section.

1.4 MATERIAL, EQUIPMENT AND FIXTURE SCHEDULE

Material, equipment and fixture schedule shall be submitted for overhead pole line assemblies including manufacturer's style or catalog numbers, specification and drawing reference numbers, warranty information, and fabrication site information.

PART 2 PRODUCTS

2.1 FABRICATION DRAWINGS

Fabrication Drawings shall be submitted for the following items consisting of fabrication and assembly details to be performed in the factory.

- Wood Poles
- Crossarms and Timbers
- Crossarm Braces
- Hardware, Pins, and Racks
- Insulators
- Guys
- Accessories

2.2 WOOD POLES

Wood poles shall be treated Southern pine in accordance with ANSI O5.1.

Poles shall be carefully selected for straightness and shall have no sweeps or short crooks exceeding the maximum sweeps and short crooks permitted in ANSI O5.1.

2.2.1 Preservative

**NOTE: Choose one of the following three types of
preservatives, according to the environment.**

Preservative used for humid, harsh environment shall be Chromated Copper Arsenate type (A) (B) (C) conforming to AWPAC4 and ASTM D 1625.

Wood poles shall be treated with waterborne preservatives conforming to AWPAC5.

2.2.2 Preservative Application

Preservative treatment shall be applied using a pressure process conforming to AWPAC1 and AWPAC4 for Southern Pine. Penetration of preservatives shall be determined as specified in AWPAC3 and complete sapwood penetration shall be obtained.

Poles that are to be given a full-length preservative treatment shall be roofed, galled, and bored before treatment. Unused holes in poles shall be plugged with treated wood-dowel pins. Field-cut gains or field-bored holes in poles shall be treated with an approved preservative compound.

2.2.3 Storage

Poles stored for any reason more than 2 weeks shall be stacked on pressure treated or decay-resistant skids of such dimensions and so arranged as to support the poles without producing noticeable distortion. Poles shall be stacked in a manner that will permit free circulation of air; the bottom poles of the stacks shall be at least 1-foot 300 millimeter above ground level or any vegetation growing thereon. No decayed or decaying wood shall be permitted to remain underneath stored poles.

2.2.4 Handling

Treated poles shall not be dragged along the ground. Pole tongs, cant hooks, and other pointed tools capable of producing indentations more than 1 inch 25 millimeter in depth shall not be used in handling the poles. No tools shall be applied to the groundline section of any pole. Groundline section is that portion between 1 foot 300 millimeter above and 2 feet 600 millimeter below the ground line.

2.3 CROSSARMS AND TIMBERS

**NOTE: Crossarms shall be avoided wherever
practicable due to failure rates and propensity for
raptor nesting causing electrical outages.**

Before pressure treatment, crossarms shall be machined, chamfered, trimmed, and bored for pins and bolts required.

Crossarms and timbers shall be straight and close-grained pressure treated Southern pine, pressure-treated to 8 pounds 35 newton minimum retention with complete sapwood penetration. Treatment of crossarms and timbers shall meet the requirements of AWP A C25.

Crossarms shall be 4-1/4 by 5-1/4 inches by 9 feet 110 by 135 millimeter by 2700 millimeter, unless other dimensions are indicated, and straight and free of twists to within 1/10 inch per foot 2.5 millimeter per 1/3 meter of length. Bends or twists shall be in one direction only.

Vertical and longitudinal strength of crossarms shall conform to IEEE C2.

2.4 CROSSARM BRACES

Crossarm braces shall be zinc-coated structural steel conforming to ASTM A 675/A 675M.

Crossarm braces shall meet the requirements of ANSI C135.6.

Angle braces shall be 60-inches 1500 millimeter span by 18 inches 460 millimeter, drop-formed in one piece from a 1-3/4 by 1-3/4-inch 45 by 45 millimeter angle.

Flat braces shall be 1/4 inch by 1-1/4 inches 6 millimeter by 32 millimeter, not less than 20-inches 500 millimeter long for arms 4 feet 1200 millimeter or less in length, and not less than 28-inches 710 millimeter long for arms exceeding 4 feet 1200 millimeter in length.

2.5 HARDWARE, PINS, AND RACKS

2.5.1 Miscellaneous Hardware

Pole-line hardware shall be hot-dip galvanized after fabrication.

Suitable washers shall be installed under bolt heads and nuts on wood surfaces. Washers used on thru-bolts and double-arming bolts shall be approximately 2-1/4-inches 60 millimeter square and 3/16-inch 5 millimeter thick. Diameter of holes in washers shall be the correct standard size for the bolts with which the washers are used. Washers for use under the heads

of carriage bolts shall be the proper size to fit over the square shank of the bolt.

Pole line hardware shall meet the requirements of IEEE C135.1 for steel bolts and nuts.

2.5.2 Pins

Pins shall be zinc-coated forged steel with lead-thread height to suit the insulator to be installed, but not less than 4-1/2-inches high by 5/8-inch diameter 115 millimeter high by 16 millimeter diameter. Shoulder shall be not less than 2-inch 50 millimeter diameter and shall be designed to distribute the load uniformly to the crossarm. Shank shall be not less than 5/8-inch diameter by 5-3/4-inch length 16 millimeter diameter by 145 millimeter length, equipped with a 2-inch 50 millimeter square washer, nut, and locknut, and shall project not less than 1/8 inch 3 millimeter nor more than 2 inches 50 millimeter beyond the locknut. Broad-base corner pins of drop-forged welded steel or malleable iron shall be used for turning small angles, as indicated.

2.5.3 Hot-Line Clamps

Connections to overhead primary conductors shall be made with hot-line clamps of the screw type with concealed threads. Thread chamber shall be filled with corrosion-resistant compound. Hot-line clamp tap conductor shall be bare soft-drawn seven-strand No. 4 5.2 millimeter diameter (No. 4) copper, except that the hot-line clamp tap conductor for lateral lines No. 2 6.5 millimeter diameter (No. 2) and larger shall be bare soft-drawn copper of the same size and stranding as the lateral line.

Stirrups shall be provided for hot-line clamp connections, shall be 4 by 4 inches 100 by 100 millimeter, and shall be constructed of bare hard-drawn copper the same size as the tap line but not less than No. 4.

2.5.4 Secondary Racks

Secondary racks shall be the 2-, 3-, or 4-wire type as required and shall be furnished complete with spool insulators.

Racks shall meet industry requirements for the strength and deflection of heavy-duty steel racks and shall be either galvanized steel or aluminum alloy.

Top of insulator points shall be rounded and smooth. Insulators shall be held in place with a 5/8-inch 16 millimeter buttonhead bolt equipped with a nonferrous cotter pin, or equivalent, at the bottom.

2.6 INSULATORS

Insulators for use on primary open-wire construction shall conform to ANSI C29.2, ANSI C29.3, ANSI C29.4, ANSI C29.6, and ANSI C29.7.

Insulators shall have a minimum wet flashover rating of 80 kV.

Suspension insulators shall be used on the primary system at corners, angles greater than 5 degrees, suspended buses, dead ends, and wherever pin insulators do not provide adequate strength.

Mechanical strength of suspension and strain insulators shall exceed the

ultimate tensile strength of the conductor or guy attached thereto.

Pin insulators used on voltages in excess of 5,000 volts phase-to-phase shall be radio-noise free.

Insulators for various uses shall have ratings not lower than the classes indicated as follows:

<u>SERVICE</u>	<u>PIN</u>	<u>LINE POST</u>	<u>SUSPENSION</u>
5,001- to 15,000-volt	56-3	27-21 or 2s	3 X 52-2*

*With a 12-inch 300 millimeter extension link in the center phase.

Spool insulators used on secondaries shall be not smaller than Class 52-2. For conductors No. 4/0 and larger, Class 52-4 spool insulators shall be used.

Insulator testing shall be in accordance with ANSI C29.2.

2.7 GUYS

Guys shall be the wrap type, except where storm guys are indicated.

2.7.1 Guy Hooks and Guy Strain Plates

Guy hooks and guy strain plates shall meet the requirements of IEEE C135.1. Steel and malleable-iron guy clamps shall meet industry requirements.

2.7.2 Guy Wires

Guy wires shall be [seven-strand copper-covered steel] [galvanized steel] with a breaking strength of not less than 10,000 pounds 45 kilonewtons.

2.7.3 Guy Protectors

Polyvinylchloride (PVC) guy protectors shall be 2-1/4-inch 60 millimeter outside width, with 100-mil 2.5 millimeter minimum thickness.

Guy protectors shall be used to visually mark the guy wire at all locations that are accessible.

2.7.4 Anchors

Anchors shall be screw type. A 15-inch 380 millimeter screw anchor with an 8-foot long by 1-1/2-inch 2-meter long by 40 millimeter diameter rod is acceptable as a 10,000-pound 45 kiloNewtons anchor.

2.8 FACTORY TESTING AND INSPECTION

Inspection of poles, crossarms, and timbers shall be accomplished by a recognized independent timber inspection company. Qualifications of the company shall be subject to approval. Poles, crossarms, and timbers shall be inspected prior and subsequent to treatment. For the material to be acceptable, the inspection company shall certify that the wood, treating material, and treatment are all in accordance with this specification.

PART 3 EXECUTION

3.1 INSTALLATION DRAWINGS

Installation Drawings shall be submitted for overhead pole line assemblies. Installation shall be in accordance with IEEE C2 for medium loading conditions, Grade B construction.

3.2 POLES

3.2.1 Gains

Gains shall be cut on the face concave side or side of greatest curvature in poles having reverse or double sweeps between the ground line and the top of the pole; the gained surfaces shall be in approximately parallel planes. Poles shall be framed as required for the application.

3.2.2 Setting Poles

Poles in straight runs shall be set in a straight line. Curved poles shall be placed with the curvature in line with the lead pole. Poles shall be set to maintain as even a grade as practical.

When the average ground run is level, consecutive poles shall not vary more than 5 feet 1500 millimeter in height. When the ground is uneven, poles differing in height shall be kept to a minimum by locating poles to avoid the highest and lowest points.

When it becomes necessary to shorten a pole, a piece shall be sawn off the top end. When poles are shortened after treatment, the shortened end of the pole shall be given an application of hot pressure treated.

Holes shall be large enough to permit the proper use of tampers to the full depth of the hole. Earth shall be thrown into the hole in 6-inch 150 millimeter maximum layers, then thoroughly tamped before the next layer is thrown in. Surplus earth shall be placed around the pole in a conical shape and packed tightly to drain water away from the pole.

Poles located at corners, angles, and dead ends shall be installed with a sufficient degree of rake to ensure sound pole-setting practices. When poles are set along the edge of cuts or embankments or where the soil may be washed out, special precautions shall be taken to ensure durable foundations. Setting depth shall be measured from the lower side of the pole. In normal firm ground, minimum pole-setting depths shall be as listed below.

MINIMUM SETTING-DEPTH OF WOOD POLES

<u>OVERALL POLE LENGTH (FEET)</u>	<u>POLES IN STRAIGHT LINES (FEET-INCHES)</u>	<u>POLES AT CURVES, CORNERS, AND POINTS OF EXTRA STRAIN (FEET-INCHES)</u>
30	5-6	5-6
35	6-0	6-0
40	6-6	7-0

MINIMUM SETTING-DEPTH OF WOOD POLES

<u>OVERALL POLE LENGTH (FEET)</u>	<u>POLES IN STRAIGHT LINES (FEET-INCHES)</u>	<u>POLES AT CURVES, CORNERS, AND POINTS OF EXTRA STRAIN (FEET-INCHES)</u>
45	7-0	7-6
50	7-6	8-0
55	8-0	8-6
60	8-0	8-6
65	9-0	9-6
70	9-6	10-0
75	10-0	10-6
80	10-6	11-6
85	11-6	12-6
90	12-6	13-6
95	13-6	14-6
100	14-6	16-0

MINIMUM SETTING-DEPTH OF WOOD POLES

<u>OVERALL POLE LENGTH (MM)</u>	<u>POLES IN STRAIGHT LINES (MM)</u>	<u>POLES AT CURVES, CORNERS, AND POINTS OF EXTRA STRAIN (MM)</u>
9000	1700	1700
11000	1800	1800
12000	2000	2100
14000	2100	2300
15000	2300	2400
17000	2400	2600
18000	2400	2600
20000	2700	2900
21000	2980	3000
23000	3000	3200
24000	3200	3500

MINIMUM SETTING-DEPTH OF WOOD POLES

<u>OVERALL POLE LENGTH (MM)</u>	<u>POLES IN STRAIGHT LINES (MM)</u>	<u>POLES AT CURVES, CORNERS, AND POINTS OF EXTRA STRAIN (MM)</u>
26000	3500	3800
27000	3800	4100
29000	4100	4400
30000	4400	4900

3.2.3 Marking

Each pole shall be marked in accordance with the requirements of ANSI O5.1. Marking on the face of the pole shall be located approximately 10 feet 3 meter from the butt on the pole. Where approved by the Contracting Officer, the marking on the face of the pole may be at other locations standard with the pole manufacturer.

Poles shall be numbered as indicated. Poles not having numbers indicated shall be numbered as directed by the Contracting Officer. Pole numbers shall consist of aluminum numerals and characters not less than 2-1/2-inches 65 millimeter high fastened to the pole with aluminum nails. Numerals shall be located to provide maximum visibility from the road or patrol route.

3.3 CROSSARMS AND TIMBERS

**NOTE: Vertical or triangular framing is preferred
over crossarm framing. Use crossarm framing only
where mandatory for ground clearances.**

Crossarms shall be set at right angles to line for straight runs and shall bisect the angle of turns.

Double crossarms shall be securely held in position by means of 5/8 inch 16 millimeter double-arming bolts. Each double-arming bolt shall be equipped with four nuts and four square washers.

Crossarms shall be bolted to poles with 5/8 inch 16 millimeter thru-bolts with square washers at each end. Bolts shall extend not less than 1/8-inch 3 millimeter nor more than 2-inches 50 millimeter beyond the nut.

3.4 CROSSARM BRACES

Crossarm braces shall be provided on crossarms.

Flat braces shall be bolted to arms with 3/8 inch 10 millimeter carriage bolts with a round washer between bolthead and crossarm and shall be secured to poles with 1/2 inch by 4 inch 13 millimeter by 100 millimeter lag screws after crossarms are leveled and aligned.

Angle braces shall be bolted to crossarms with 1/2 inch 13 millimeter bolts with a round washer between bolthead and crossarm and shall be secured to poles with 5/8 inch 16 millimeter thru-bolts.

3.5 HARDWARE, PINS, AND RACKS

Eyebolts, bolt eyes, eyenuts, strain load plates, lag screws, guy clamps, fasteners, hooks, shims, and clevises shall be used wherever required to adequately support and protect the poles, crossarms, guy wires, and insulators. Hardware shall be the correct size to fit the pole and crossarms on which they are being installed.

Racks for dead-ending four No. 4/0 11.7 millimeter diameter (No. 4/0) or larger conductors shall be attached to poles with three 5/8 inch 16 millimeter thru-bolts. Other secondary racks shall be attached to poles with at least two 5/8 inch 16 millimeter thru-bolts.

Minimum vertical spacing between conductors shall be as follows:

<u>SPAN LENGTH (FEET)</u>	<u>VERTICAL SPACING BETWEEN CONDUCTORS (INCHES)</u>
Up to 200	6
201 to 250	8
251 to 300	12

<u>SPAN LENGTH (METER)</u>	<u>VERTICAL SPACING BETWEEN CONDUCTORS (MILLIMETER)</u>
Up to 60	150
61 to 76	200
77 to 91	300

3.6 GUYS

Guys shall be provided at the locations indicated, where conductor tensions are not balanced as at angles and deadends, and elsewhere as necessary or as required by IEEE C2. Where points of strain on a pole are separated by more than 3 feet 900 millimeter, separate down-guys shall be installed at each point of strain. Where a single guy cannot provide the required strength, two or more guys shall be provided.

A minimum of two guy hooks and two pole shims shall be provided for wrap guys. Three-bolt or offset guy clamps or approved guy grips shall be provided at each guy terminal.

Where the total unbalanced load on a pole exceeds 10,000 pounds 45 kilonewtons, multiple guys and anchors shall be installed. Guy strength shall be determined from the minimum holding power of any component.

Thimbles or thimble eyes shall be provided on anchor-rod and eye-bolt guy attachments to protect the guy strand. Care shall be taken to prevent damage to the copper coating. Nicks or similar damage will be cause for rejection.

Whenever possible, guys shall have a lead-to-height ratio of 1 to 1 and a minimum lead-to-height ratio of 1/2 to 1. When field conditions prevent the lead-to-height ratio of 1 to 1, anchors shall be placed in a location approved by the Contracting Officer. Guy strength shall be increased by the ratio of the sine of the lead angle indicated to the sine of the lead angle provided. Storm guys and other guys where road clearance is essential shall be installed with a minimum lead. Storm guys shall be tensioned sufficiently to remove slack and present a neat appearance.

Ground end of each guy attached to a ground anchor shall be equipped with a half-round galvanized steel or gray PVC guy protector at least 7 feet 2135 millimeter long. Protector shall be securely clamped or bolted to the anchor rod or guy wire near the bottom and to the guy wire near the top.

Where shown on the drawings, guy wires shall be equipped with epoxy-bonded fiberglass strain insulators. Length of fiberglass shall be as indicated and shall be of sufficient additional length to provide a minimum 12 inch 300 millimeter clearance between the nearest energized surface and the strain insulator fitting farthest from the pole. When loaded to the tension indicated, fiberglass strain insulators shall be loaded to not more than two-thirds of the manufacturer's catalog rating.

Guys shall be solidly bonded to the system ground. Span guys shall be solidly grounded at each point of attachment to a pole. Guy wires shall be electrically bonded to the anchor rods by means of suitable guy-bond clamps.

Guy anchors and attachments shall provide a strength exceeding the required guy strength.

Anchors shall be installed so that the guy will be in a straight-line pull. Minimum strength of guy and anchor assembly shall be 5,000 pounds 22 kilonewtons.

3.7 FIELD TESTING

At least one anchor of each capacity installed shall be field-tested to ensure that the anchor develops rated holding power as indicated, without noticeable creepage. In the event of failure of a test anchor, all anchors of the size that failed shall be tested and those that fail shall be replaced; replacements shall be tested in the same manner as the original anchor. Materials, labor, and equipment required to perform the above test and for replacing anchors that fail shall be furnished at no additional cost to the Government. Anchors shall be tested prior to hanging guys. Anchors to be used as test anchors will be picked at random by the Government after all anchors have been installed.

-- End of Section --